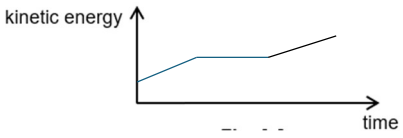
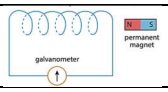
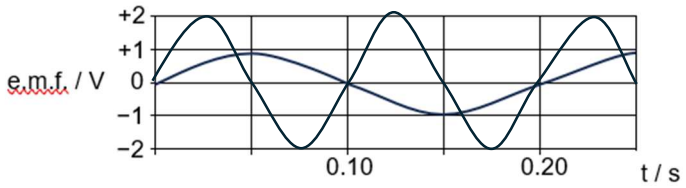
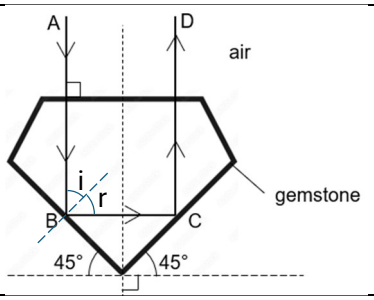
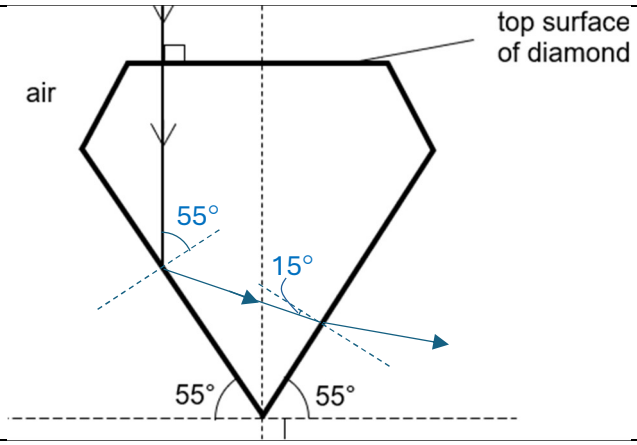
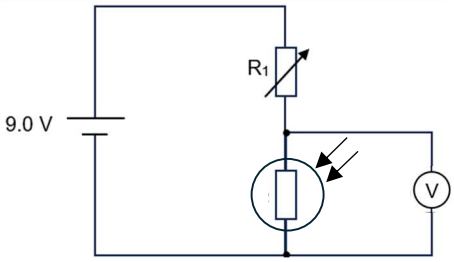
2024 4E Physics Prelim Exam Mark Scheme

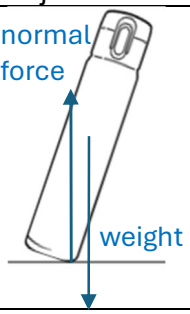
1	2	3	4	5	6	7	8	9	10
B	C	B	A	D	C	D	A	A	B
11	12	13	14	15	16	17	18	19	20
B	D	C	D	B	D	C	A	A	D
21	22	23	24	25	26	27	28	29	30
A	C	B	C	D	D	A	D	B	B
31	32	33	34	35	36	37	38	39	40
B	A	C	D	B	C	C	A	C	D

1a	upward force equals to weight (in magnitude) upward force and weight are opposite in direction / resultant force is zero	1 1
1b	F = ma F_{up} – 250 000(10) = 250 000 (4.0 – 0)/10 F_{up} – 2 500 000 = 100 000 F_{up} = 2 600 000 N	 1, 1 1
1c	Displacement = area under graph = 0.5(15)(4.0) − 0.5(10)(4.0) + 0.5(20)(2.0) = 30 m	1 1
		[7]
2a	Force per unit area	1
2bi	$F_1/A_1 = F_2/A_2$ $100/10 = F_2/50$ F_2 = 500 N	 1 1
2bii	$F_1d_1 = F_2d_2$ $100(20) = 500(d_2)$ d_2 = 4.0 cm	 1 1
2c	Pressure will not be transmitted as gas is compressible	1
		[6]
3a	Metal is a better thermal conductor than glass Energy is transferred out from the boy quicker *//reject Energy transferred from metal to surrounding, absorb heat//*	1 1
3b	Particles at the heated end are **vibrating** about their fixed positions **more vigorously,** they **collide with neighbouring particles and pass on energy** to cause them vibrate about their fixed position also more vigorously. This process continues till the other end.	1 1
3ci		1
3cii	Energy transferred to water = energy transferred from ice $mc\Delta\theta = mc\Delta\theta + ml_f + mc\Delta\theta$ $150(4.2)(30 – \theta_f) = 50(2.1)(5) + 50(330) + 50(4.2)\theta_f$ $18900 – 630\theta_f = 525 + 16500 + 210\theta_f$ $1875 = 840\theta_f$ 2.2 °C = θ_f	 1,1 1

		[8]
4a	Disinfection/sterilisation/kill bacteria and viruses/sun-tanning bed/anti-forgery of printed notes	1
4b	hinder chemical reaction/ affects cell process/ damage DNA results in cell death, mutations	1 1
4ci	10^{-8} m	1
4cii	$v = f \lambda$ $300\,000\,000 = f\ 10^{-8}$ $f = 3.0 \times 10^{16}$ Hz	 1 1
		[6]
5a	Negatively charged	1
5b	dirt particles (negatively charged) attract to metal body unlike charges attract *(accept like charges repel)* (open cover) knock on metal body	1 1 1
		[4]
6a	*//at least 3 field lines with direction shown//*	1
6b	use a compass	1
6c	Iron is **magnetic material** so the nails get **magnetised**/ becomes induced magnets Iron nails attracted to the solenoid	1 1
6d	No longer attracted to solenoid, (iron) easily demagnetised	1
		[5]
7a	clockwise	1
7b	The current carrying coil experiences forces, in the magnetic field of the magnet / interaction of magnetic field of current-carrying coil and the magnet produces forces on coil forces on each side of the coil are opposite in direction	1 1
7c	Soft iron concentrates magnetic field lines Increases the strength of magnetic field	1 1
7d	Reverses direction of current in coil every half a revolution	1
		[6]
8ai		1
8aii	When **the magnet** (north pole) **moves towards the solenoid**, the deflection of the **galvanometer** shows the **direction of current in the solenoid** Using the right-hand grip rule, **the polarity of the solenoid facing the magnet** is found to be (north pole) opposing the movement of the magnet.	1 1 1
8bi	Coil experiences a changing magnetic field linking to it	1
8bii	Electrical contact between the carbon brush and the coil / allow the coil to be rotated without being twisted	1
8biii		1 Amplitude 1 period
		[8]

9a		1
9b	Total internal reflection is the complete reflection of a light ray in an optically denser medium at the boundary with an optically less dense medium.	1
9c	<u>The volume has to be 0.16</u> For 3.5 carat of garnet, $v = m/\rho$ $= 3.5(200/1000) / 7.0$ $= 0.10\ cm^3$ (not equal to $0.16\ cm^3$) For 2.8 carat of topaz, $v = m/\rho$ $= 2.8(200/1000) / 3.5$ $= 0.16\ cm^3$ For 1.6 carat of opal, $v = m/\rho$ $= 1.6(200/1000) / 2.0$ $= 0.16\ cm^3$ The critical angle is lesser than 45° for TIR to occur For topaz, $C = \sin^{-1}(1/n)$ $= \sin^{-1}(1/1.61)$ $= 38.4°$ For opal, $C = \sin^{-1}(1/n)$ $= \sin^{-1}(1/1.37)$ $= 46.9°$	1 ($v = m/\rho$) 1 ($C<45°$) 1 ($C=\sin^{-1}(1/n)$ 1 (topaz)
9di	Critical angle is the angle of incidence in an optically denser medium for which the angle of refraction is the optically less dense medium is 90°.	1

9dii		2 (light rays) 1 (normal)
9diii	More light is reflected within the diamond and go towards the top surface of the diamond / less light is refracted out of the diamond	1
		[11]
10a	Yes **Count rate did not drop after paper** implies there may be beta-particles and gamma-particles emitted but **not alpha particles**. **Count rate dropped after aluminium** confirms existence of **beta particles**	1 1 1
10b	Random process	1
10c	Background radiation	1
10di	6 half lives 6 × 1600 = 9600 years	1 1
10dii	Axes label with units Curve with correct half-lives	1 1
		[9]
11ai	0 Ω	1
11aii	9.0 (R_2 / (R_2 + 1000)) = 6.0 3R_2 = 2R_2 + 2000 R_2 = 2000 Ω	1 1
11aiii		1 (LDR circuit symbol) 1 circuit
11bi	increase resistance to **increase the heating effect** *(accept increase resistance)*	1
11bii	P = VI 45 = 240 I I = 0.19 A	 1 1
11biii	Cost = E × unit cost = Pt × unit cost = 100(45/1000)(2)30 = 270 cents	 1 1
		[10]

12ai	There is **clockwise moment due to the 2N weight** about the pivot Q, Since the steelyard is balanced, the **weight of the steelyard** must be between PQ to produce **anticlockwise moment**.	1 1
12aii	Moment = fd = 2.0(10) = 20 Ncm	 1
12aiii	acwm = cwm w(20) + 20 = 2.0(60) *//award 1 mark if the 20 N cm is missing)* w = 5.0 N	 1 1
12aiv		1
12bi	Centre of gravity is an imaginary point where the entire weight of the object seems to act.	1
12bii		1
12biii	Clockwise moment due to weight / weight acts out of base area	1
12biv	No change, centre of gravity remains at the same point. *(accept increase in mass causes higher inertia, thus more stable)*	1
		[10]